

SUPERSTREETS AND MEDIAN U-TURNS

GIL CHLEWICKI, PE

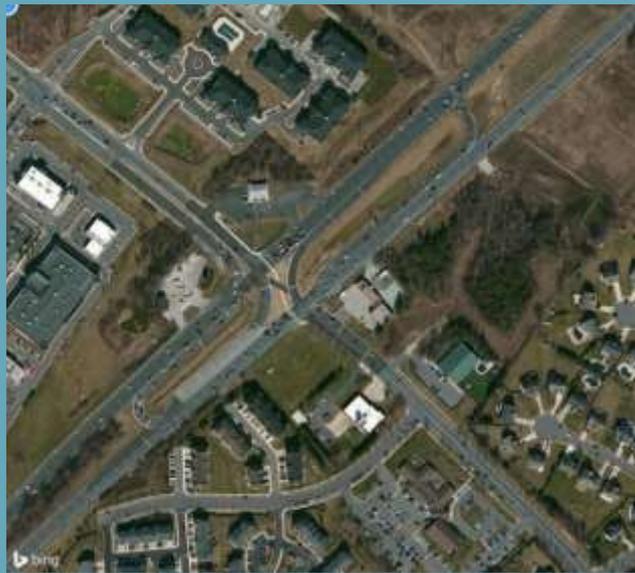
ADVANCED TRANSPORTATION SOLUTIONS

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Fairfax County
Presentation

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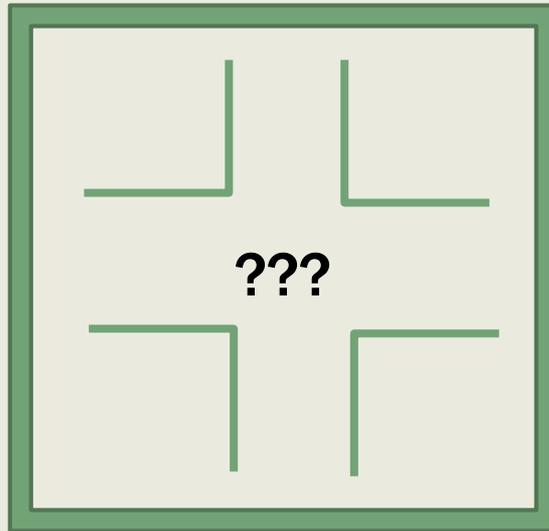
OUTLINE

- 1. What are the problems?**
- 2. What is a superstreet and how does it solve the problems?**
- 3. What is a median u-turn intersection and its benefits?**
- 4. How do pedestrians and bicyclists benefit?**
- 5. Are these designs safe?**
- 6. Conclusions**

WHAT ARE THE PROBLEMS?

Visualize some of the intersections along
Route 123 in Tysons.

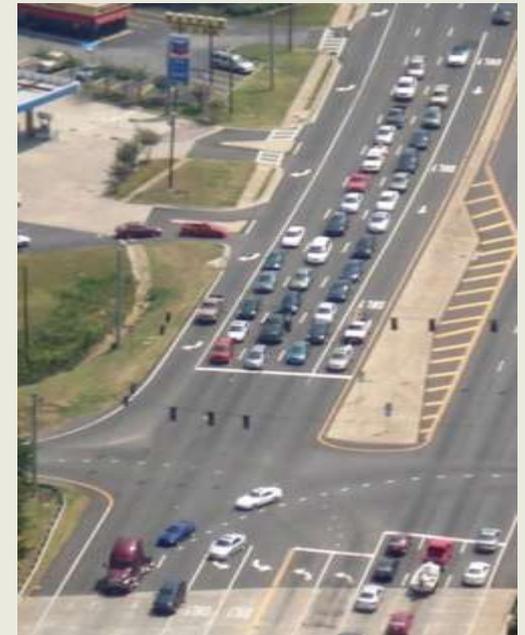
What do you see? Who do you see?



Insert mental image of your intersection here

WHAT ARE THE PROBLEMS?

- **Increasing Congestion**
- **Too Many Crashes**
- **Mobility for all modes**
 - Bicycles, Pedestrians, Transit
- **Not Enough Funding**
- **Time Consuming Projects**
- **Inability for more right-of-way**
- **Impacts of projects**
 - Environmental, social, economic



WHY INNOVATIVE INTERSECTIONS & INTERCHANGES?

An aerial photograph of a busy multi-lane intersection. The road has several lanes in each direction, with cars and trucks moving through. A large, bright yellow cloud-shaped graphic is superimposed over the center of the intersection, containing text. The surrounding area includes trees, a parking lot with several cars, and a building with a red roof.

**Congestion cannot
always be solved by
adding more lanes**

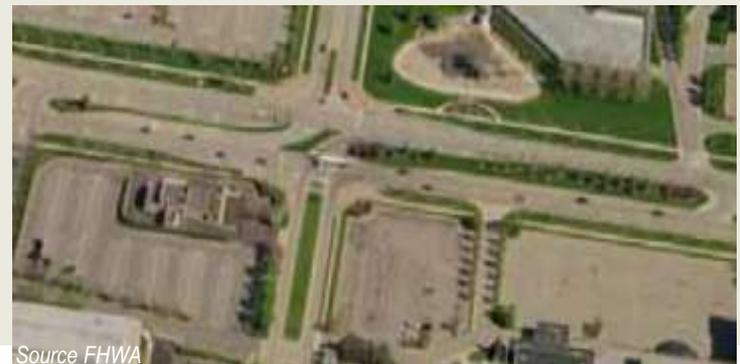
Intersections are usually the bottlenecks along high volume roadways.

METHODS OF REDUCING CONGESTION

INCREASE SUPPLY – Add more lanes

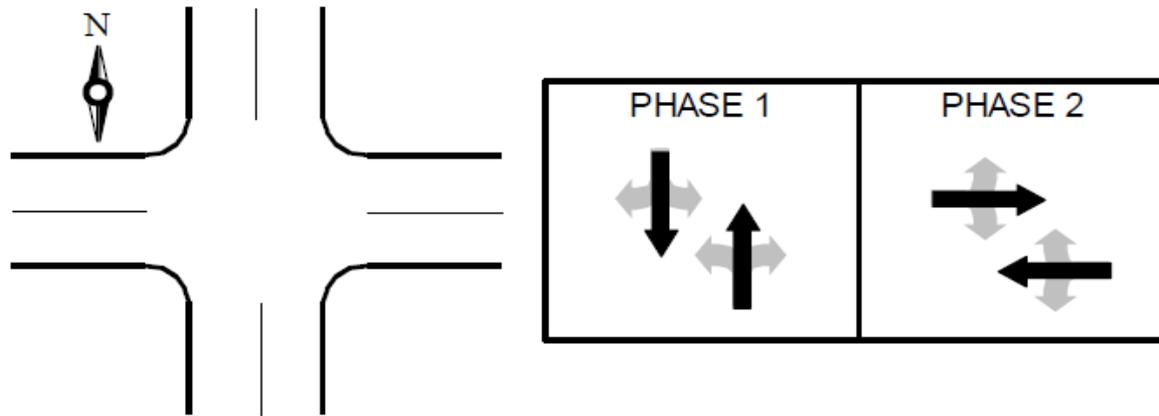
REDUCE DEMAND – Change modes of travel, Improve network, Move traffic to locations that still have capacity.

IMPROVE TRAFFIC FLOW – Better signal timing, Eliminating weaving issues, Reduce signal phasing

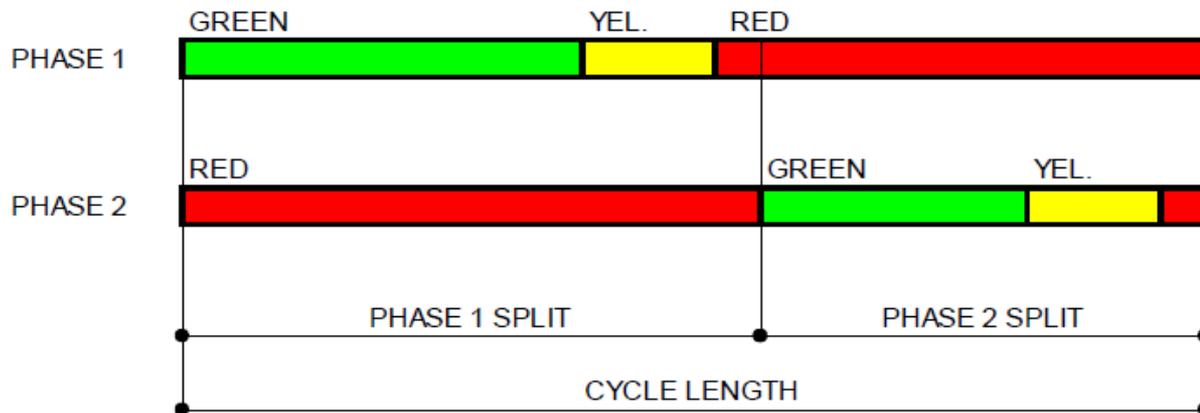


Source FHWA

SIGNAL PHASING



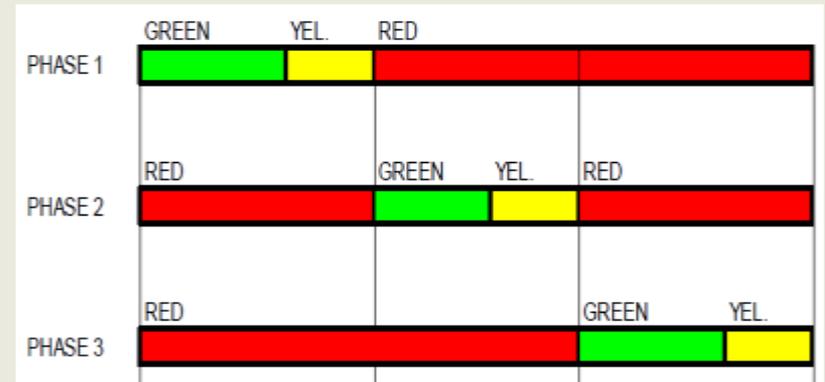
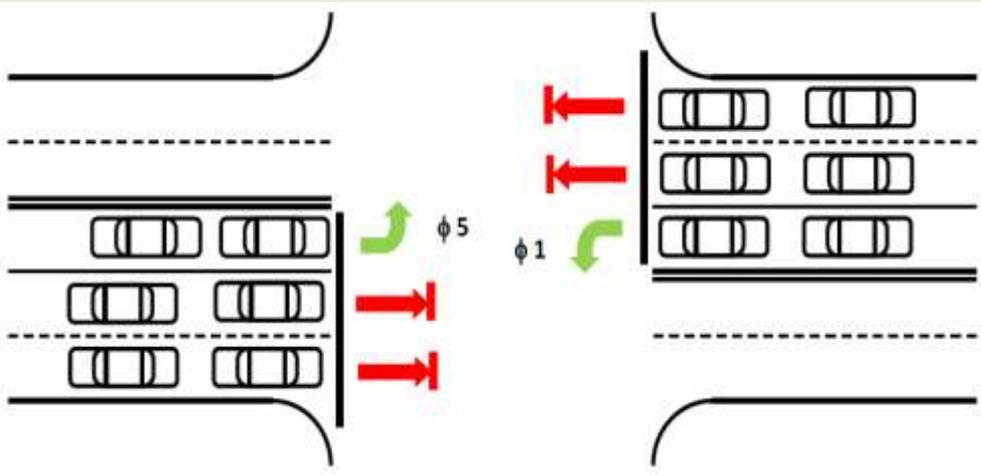
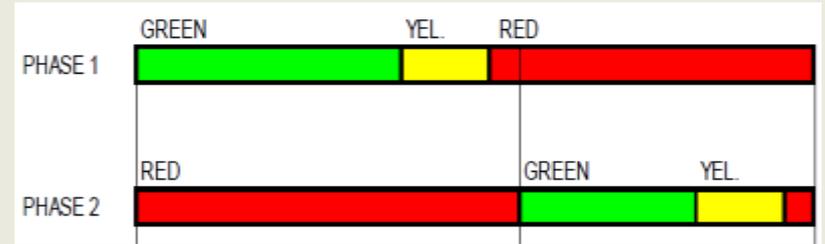
Basic two-phase signal operation



SIGNAL PHASING

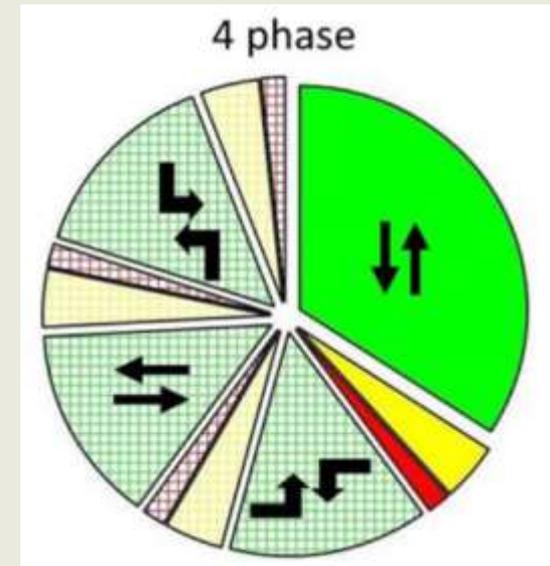


Adding “protected” left-turn phases is common as volumes increase



NEW DEVELOPMENT ALONG ARTERIAL

Problem: Proliferation of Four-Phase Signals

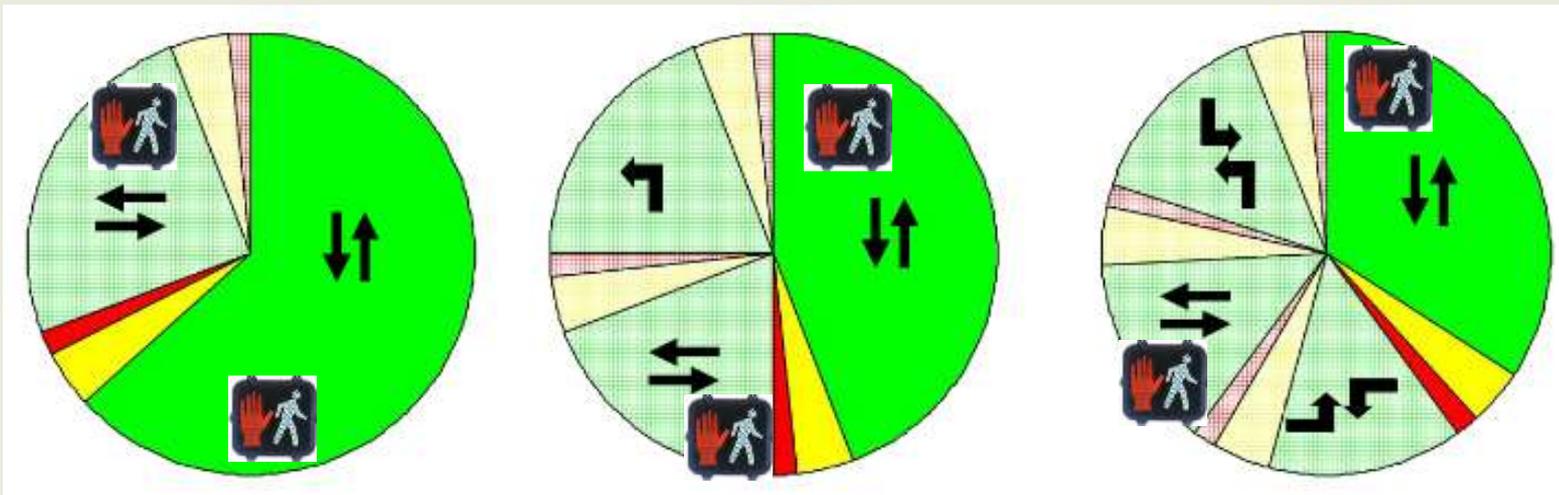


SIGNAL PHASING

Adding more phases “steals” time away from the major through movement and can increase intersection delays



- More phases also add more “lost time”



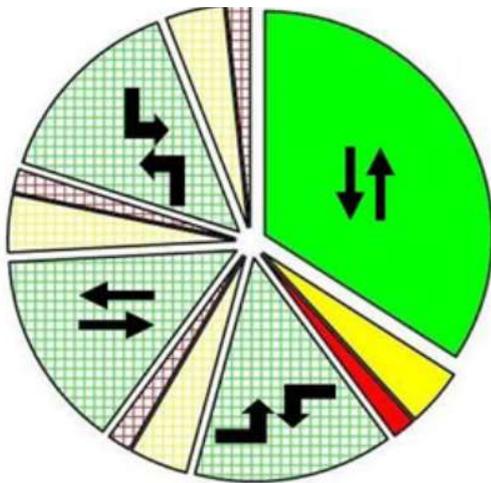
SIGNAL PHASING

Adding more phases “increases” the signal cycle length by needing more time for each movement, which causes even more delay

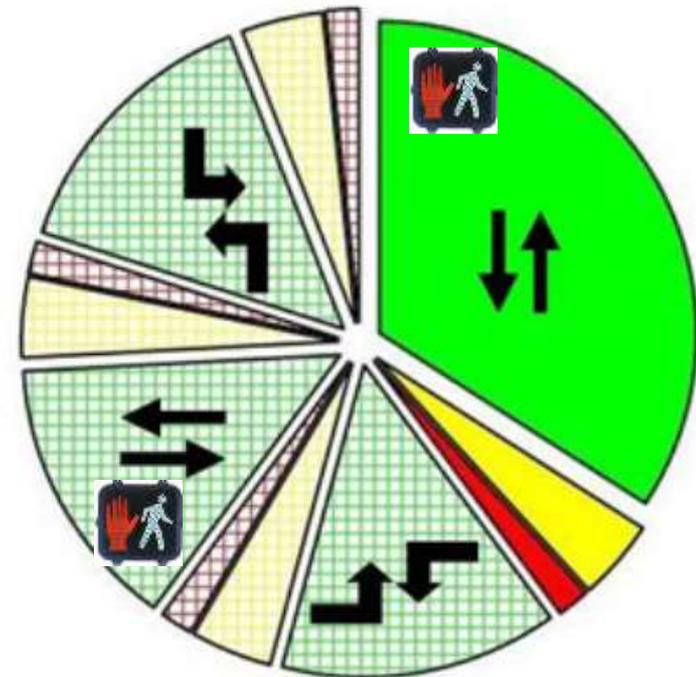


- Longer Cycle Length

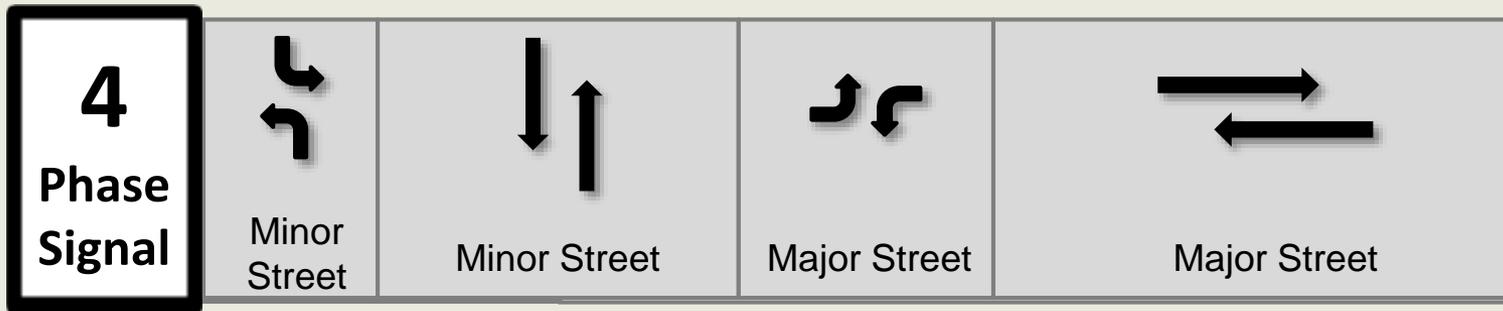
90 Second Cycle



180 Second Cycle



SIGNAL PHASING



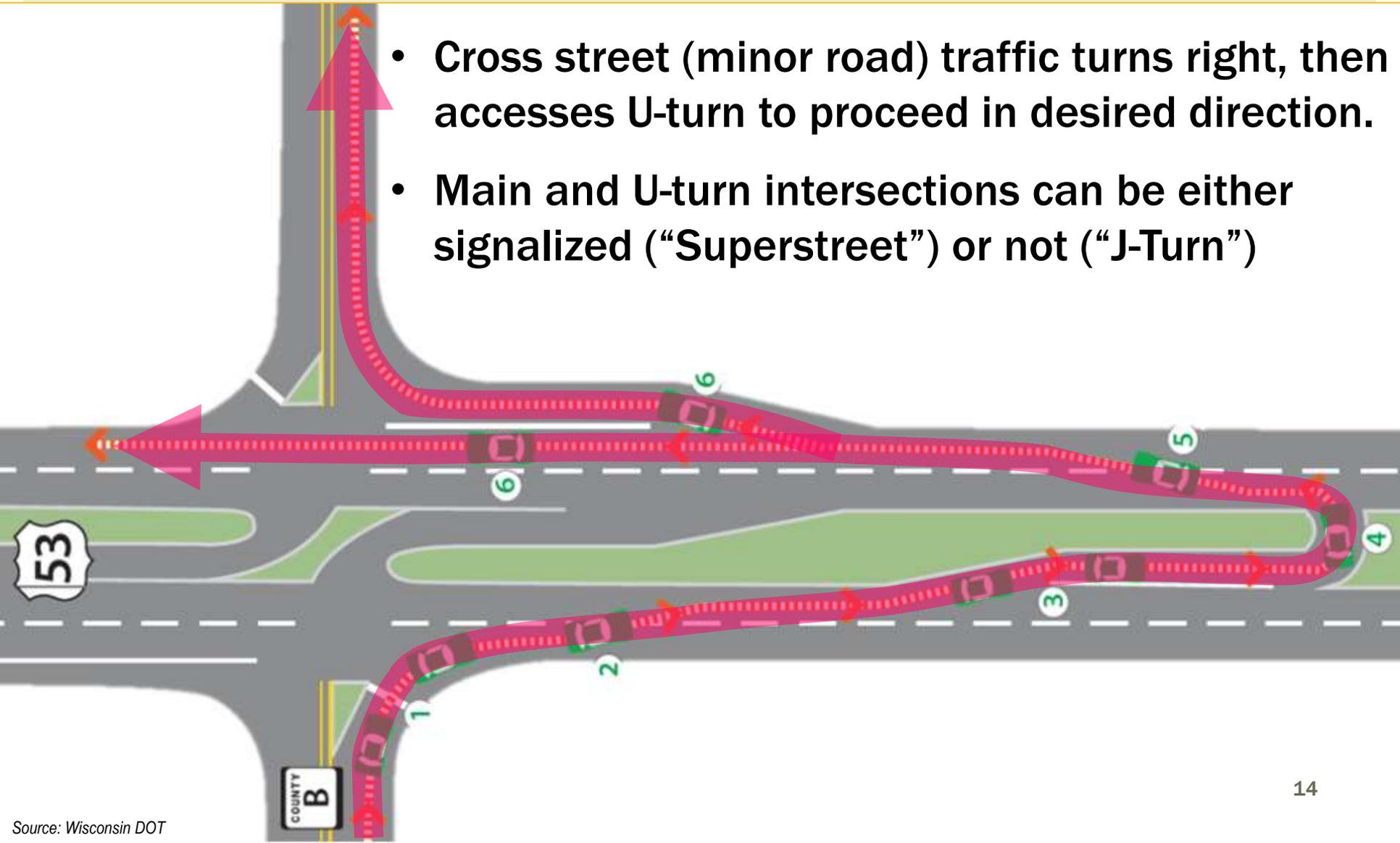
Strategically relocating left turn movements can provide more green time to through traffic



**WHAT IS THE SUPERSTREET &
WHERE IS IT APPLICABLE?**

SUPERSTREET DISTINGUISHING FEATURES

- Cross street (minor road) traffic turns right, then accesses U-turn to proceed in desired direction.
- Main and U-turn intersections can be either signalized (“Superstreet”) or not (“J-Turn”)



SIGNALIZED “SUPERSTREET”



SIGNALIZED “SUPERSTREET”



SR 4 Bypass at Symmes Rd Fairfield, OH



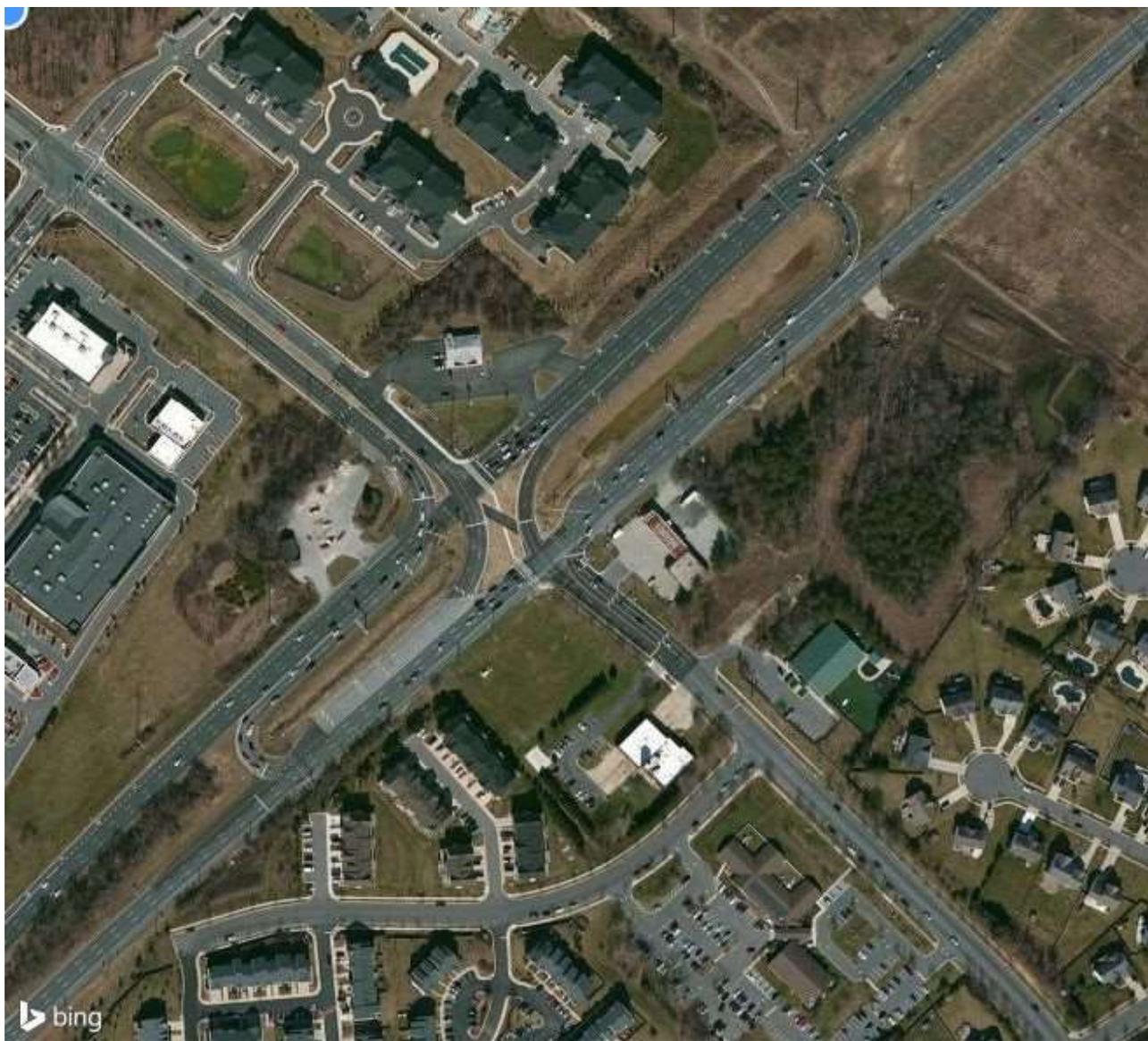
SR 4 Bypass at Symmes Road in Fairfield, OH

Signalized Superstreet



US-15/501 in Chapel Hill, NC

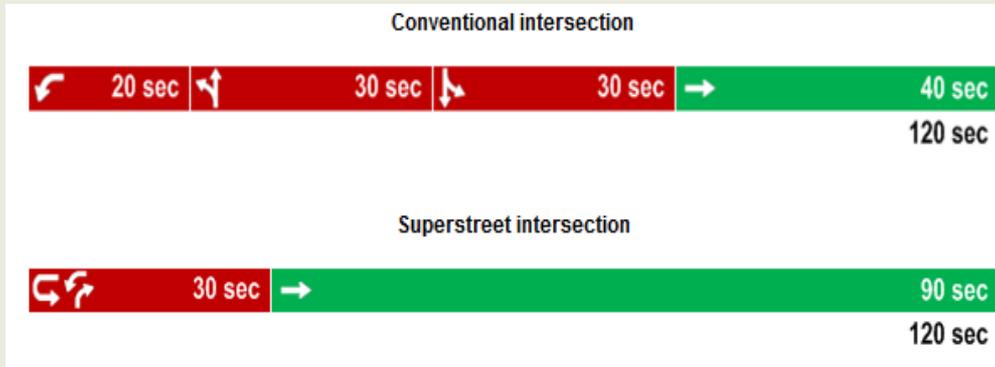
Superstreet variation with closed median at main intersection (left-turns from major highway made via U-turns)



MD 3 @ Waugh Chapel Road in Crofton, MD (1 hour east of Fairfax)

Superstreet variation with closed median at main intersection (left-turns from major highway made via U-turns)

BETTER SIGNAL OPERATIONS



- Superstreets typically operate with only 2-phases allowing more green time to the major street through
- Shorter cycle lengths than comparable conventional intersections may be possible
 - Shorter cycles reduce delay for most vehicles and for pedestrians

Superstreets offer an ability to have different cycle lengths in the two directions of the major street

BETTER SIGNAL OPERATIONS

Conventional intersection



120 sec

Average Delay

42 sec | 34 sec | 34 sec | 27 sec

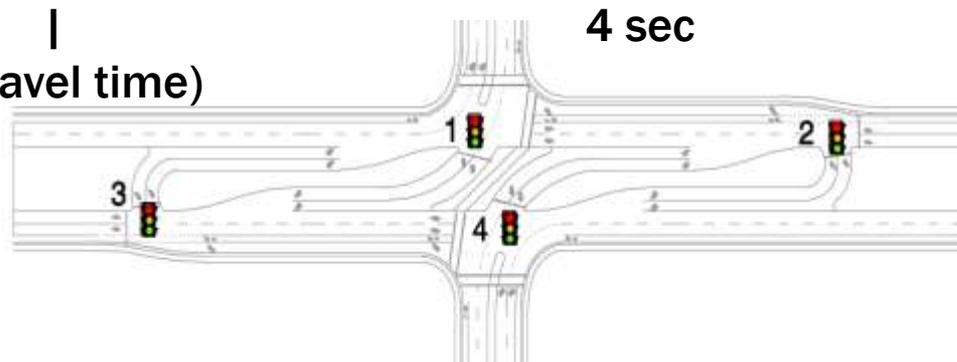
Superstreet intersection



120 sec

Average Delay

34 sec
(+ 12 sec added travel time)



BETTER SIGNAL OPERATIONS

Superstreet intersection



Average Delay

34 sec

(+ 12 sec added travel time)

4 sec

120 sec



Average Delay

22 sec

(+ 12 sec added travel time)

3 sec

60 sec

80 sec



Average Delay

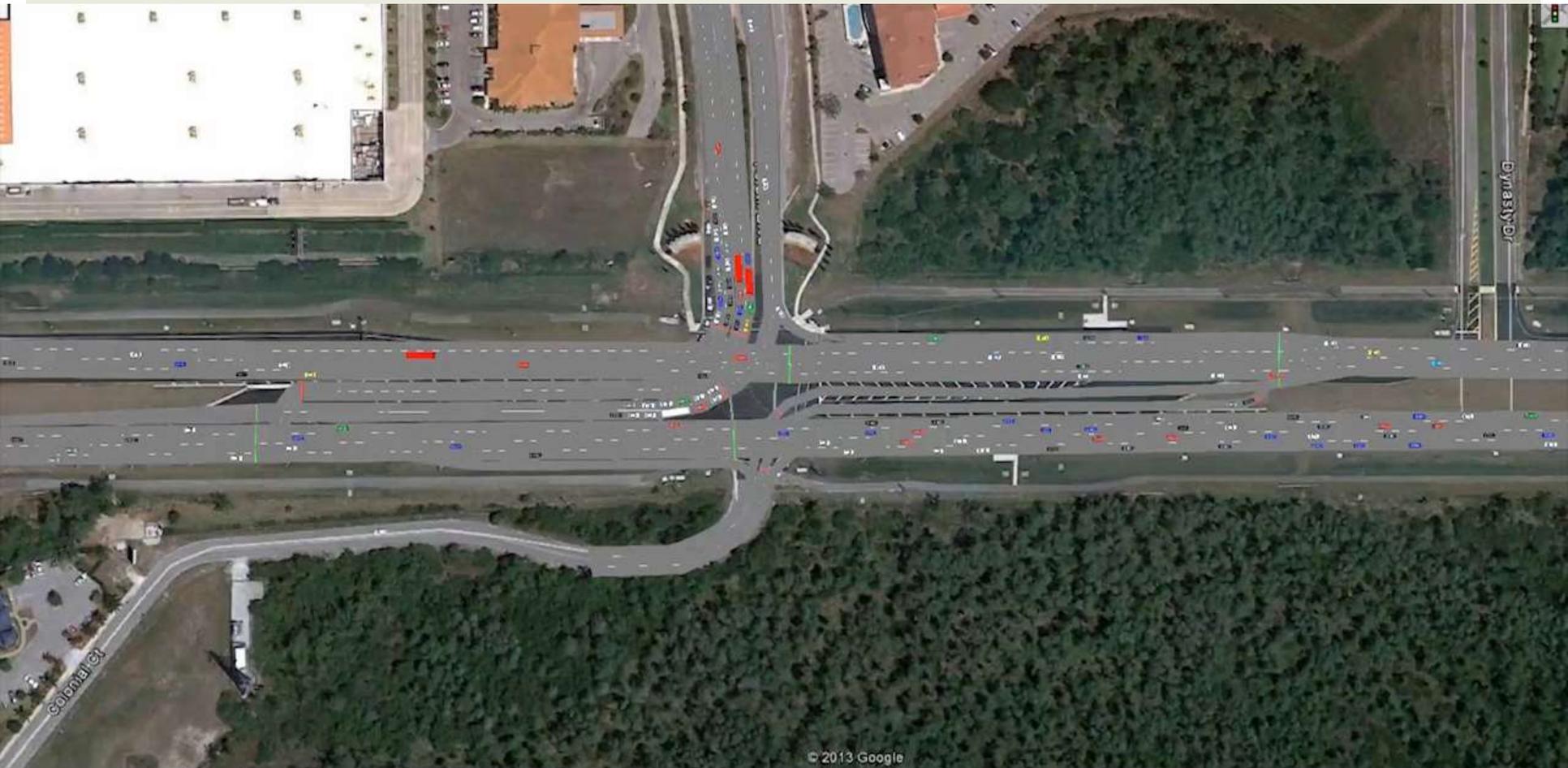
23 sec

(+ 12 sec added travel time)

8 sec

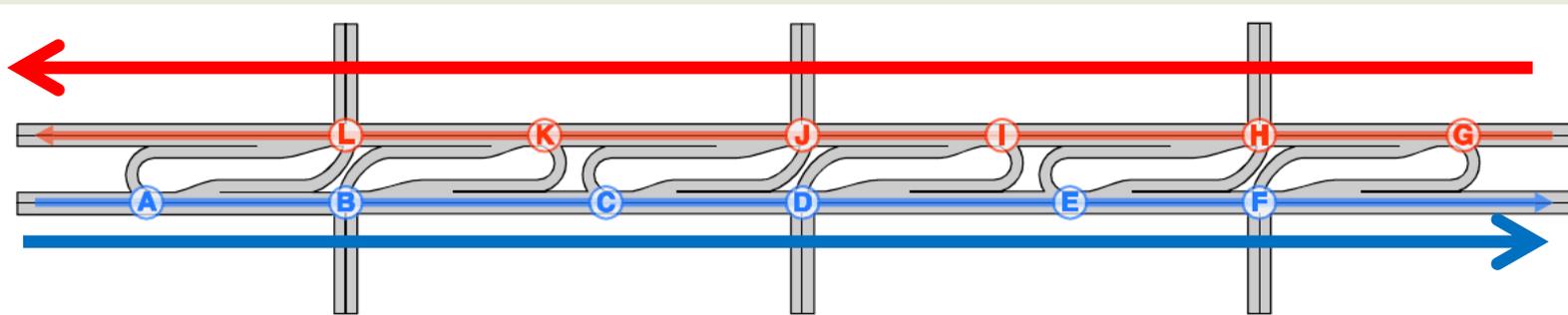
120 sec

SUPERSTREET SIMULATION



BI-DIRECTIONAL PROGRESSION

- Each direction may operate independently
- Directions can be progressed at different speeds and/or signal spacing



Direction	Parameter	F	E	D	C	B	A
Right to left	Signal	F	E	D	C	B	A
	Distance from previous signal, ft	750	650	1000	700	600	Not applicable
	Offset to start of green, sec	74	59	46	26	12	0
Left to right	Signal	G	H	I	J	K	L
	Distance from previous signal, ft	Not applicable	600	850	1050	600	600
	Offset to start of green, sec	0	12	29	50	62	74

Note: Assumed progression speed of 50 feet per second (34 mph) in both directions



SUPERSTREET CORRIDOR

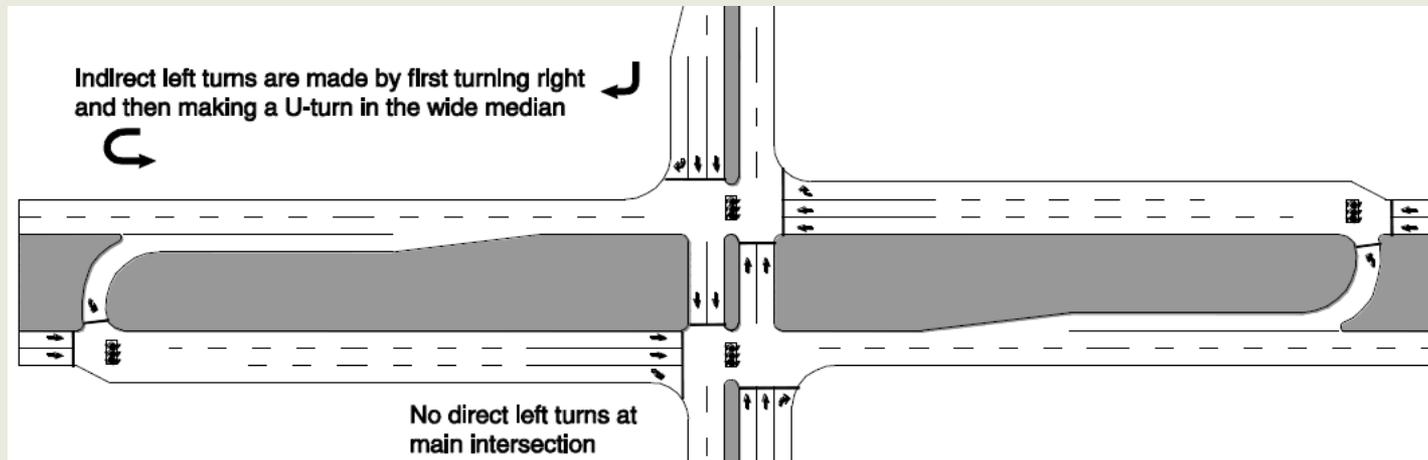
US 17 in
Brunswick
County, NC
Wilmington /
Leland, NC

SUPERSTREET VIDEO
US 17 WILMINGTON/LELAND, NC

**WHAT IS THE MEDIAN U-TURN
(MUT) & WHERE IS IT
APPLICABLE?**

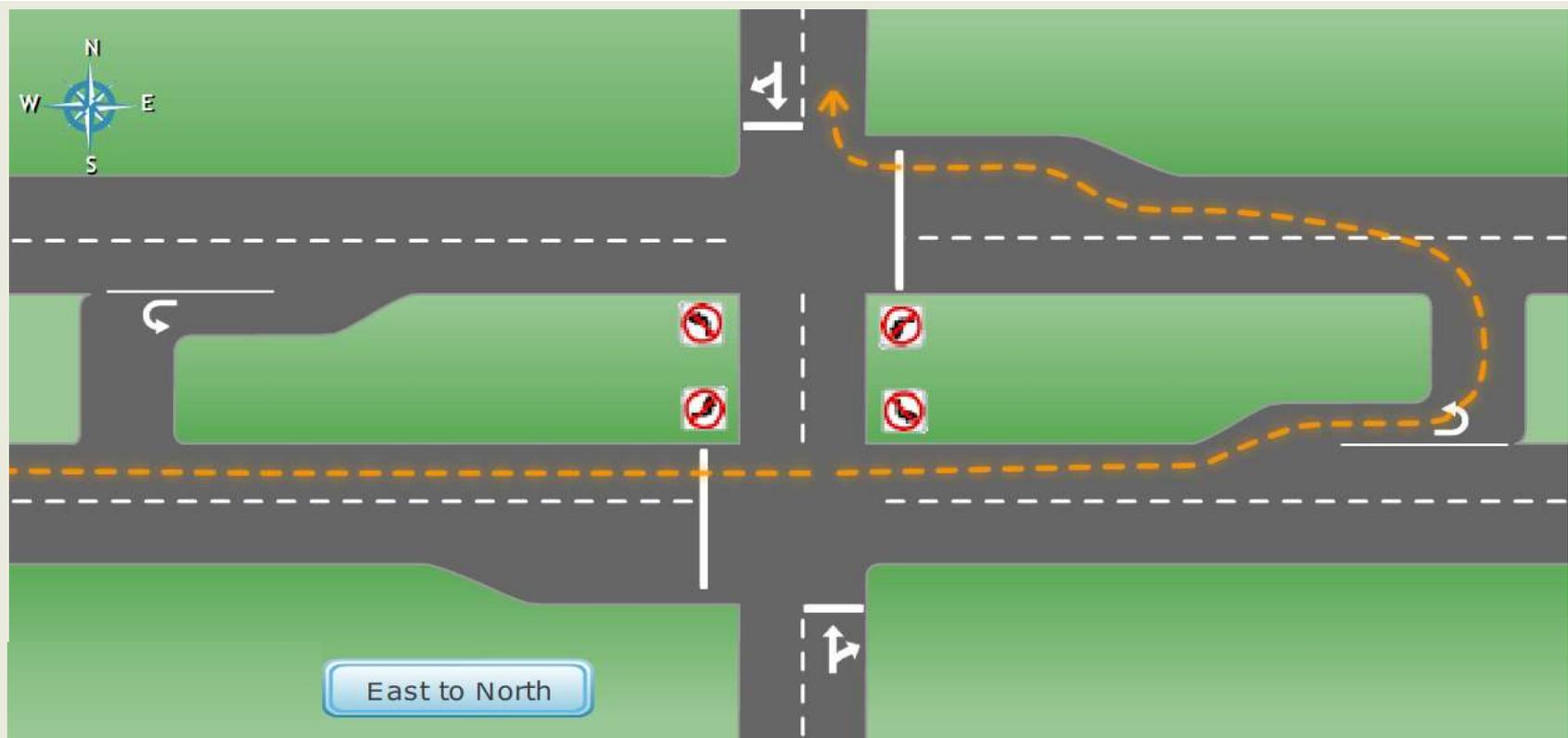
MUT – Median U-Turn

(aka Michigan Left)



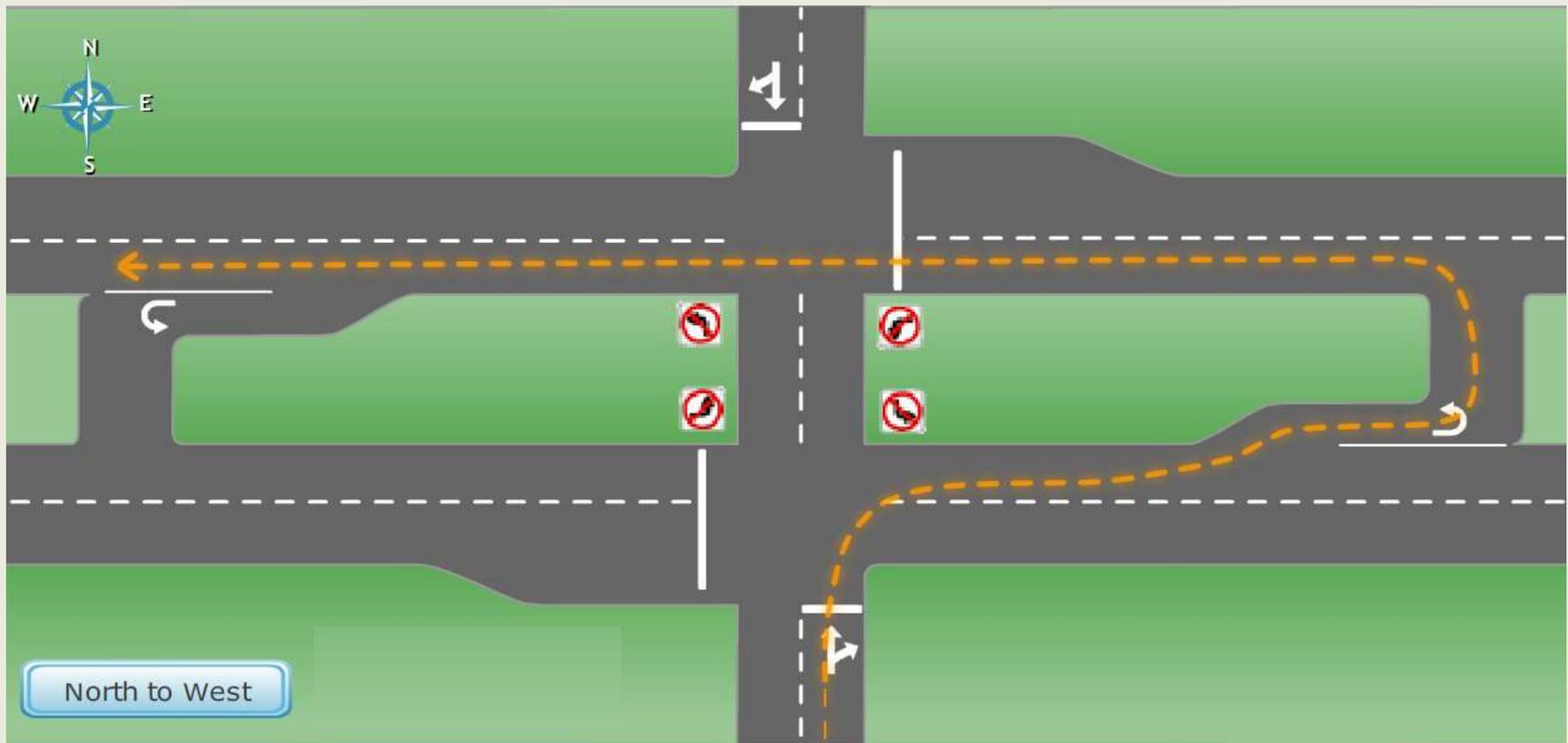
- At-grade intersections with *indirect* left turns using a U-turn movement in a wide median and/or loon
- The MUT eliminates direct left turns on both intersecting streets, reducing the number of signal phases and conflict points at the main intersection

MUT – LEFT TURN FROM MAJOR ROAD



Vehicles on the major street (or the street with the median) that want to turn left are directed through the main intersection to a U-turn movement at a downstream directional crossover (usually signalized), and proceed back to the main intersection to then turn right onto the minor street.

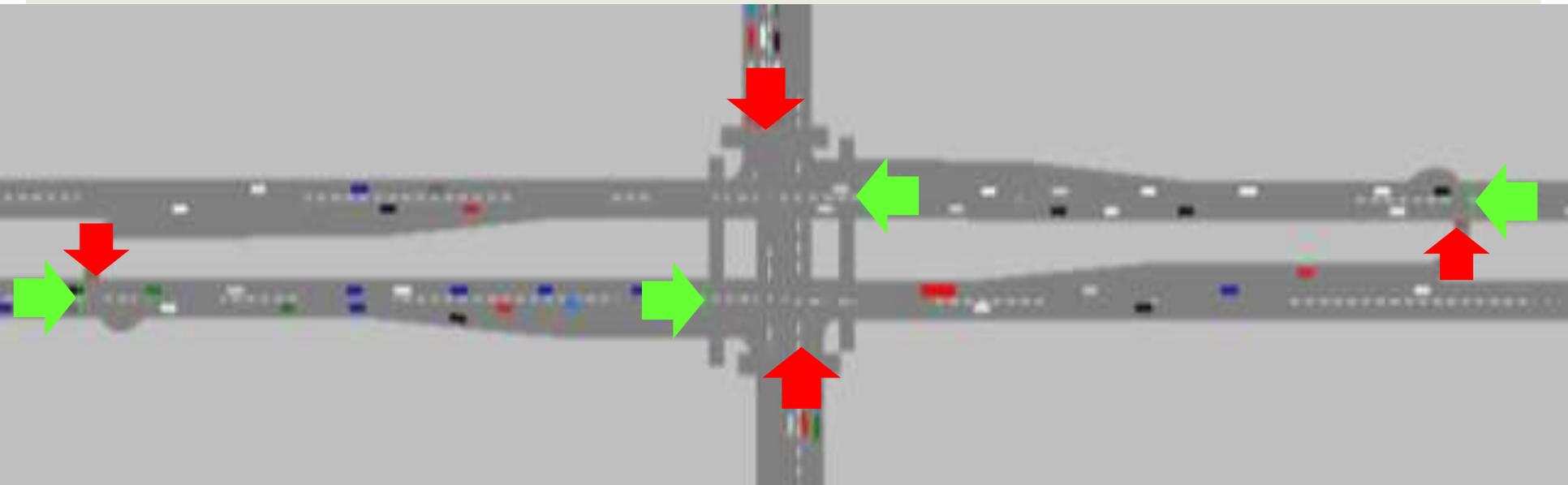
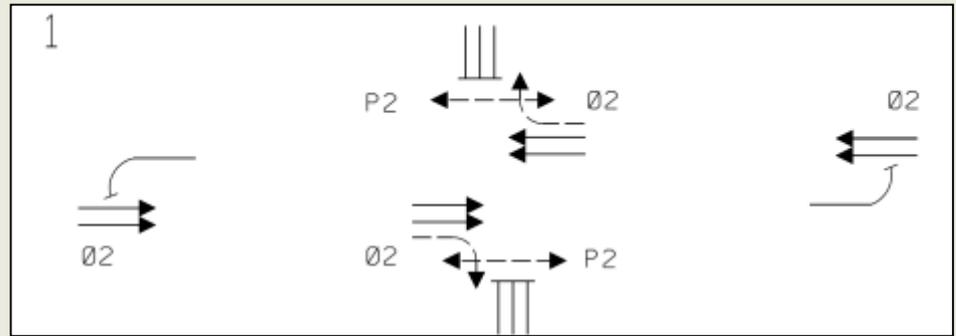
MUT – LEFT TURN FROM MINOR ROAD



Vehicles on the minor street that wish to turn left at the major street are directed to turn right, make a U-turn movement at the same crossover, and then proceed through the main intersection.

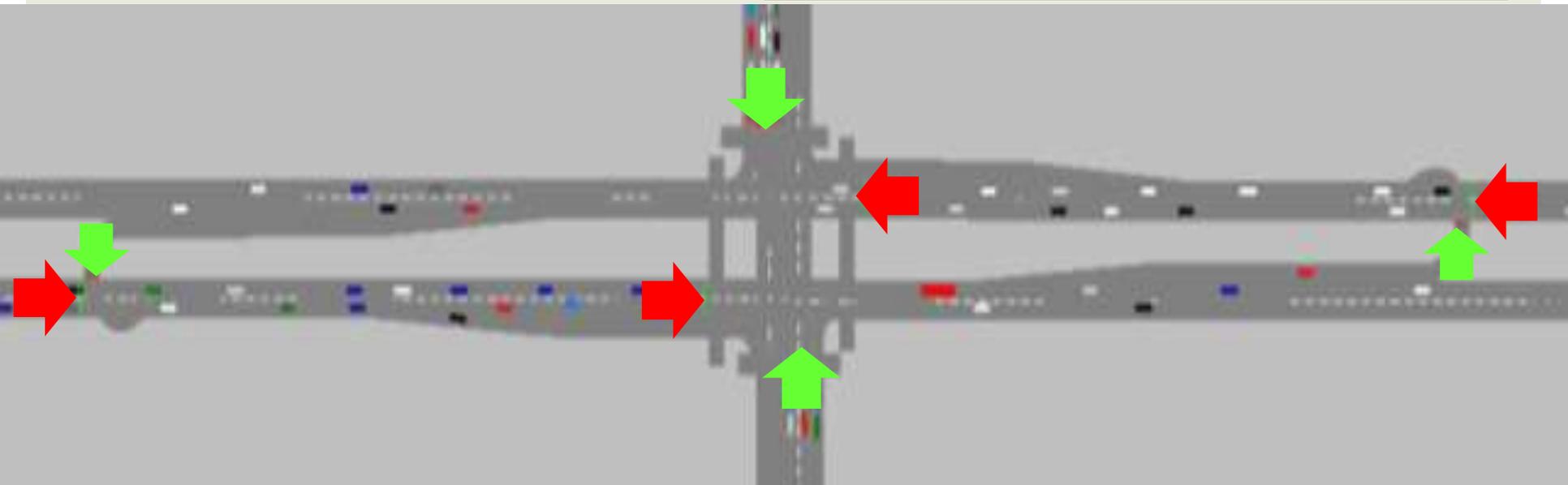
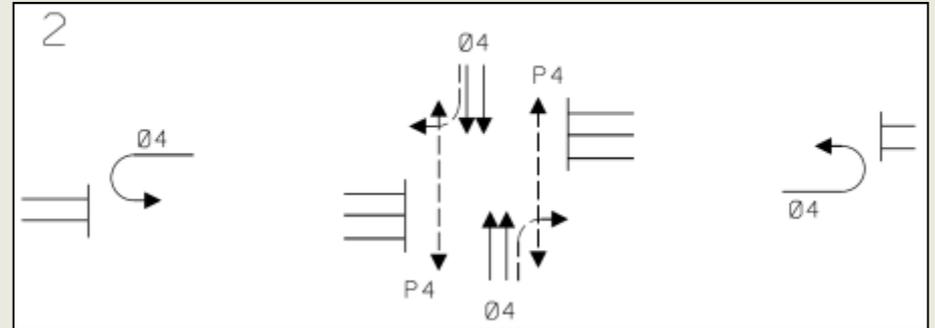
BASIC SIGNAL PHASING

Phase 1 - Major Street Through



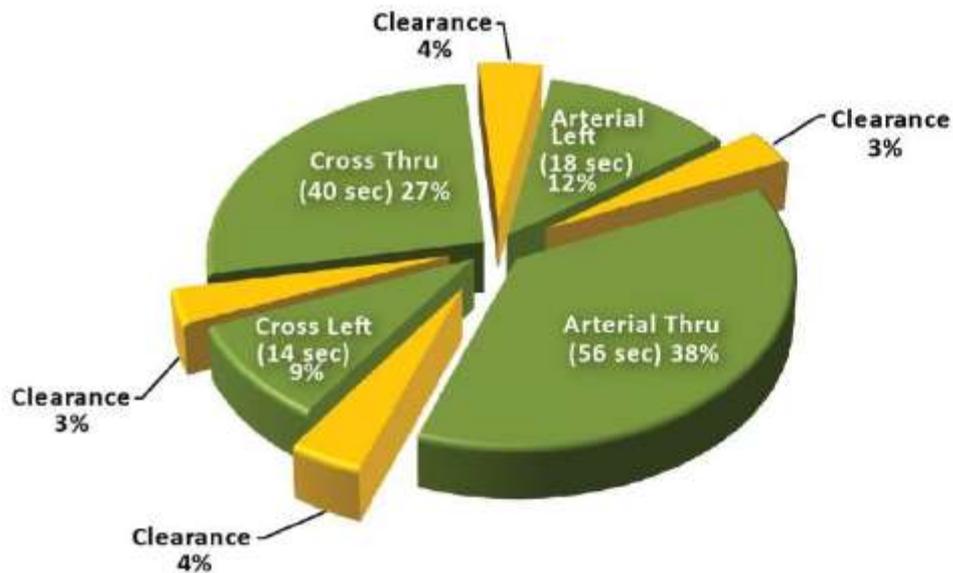
SIGNAL PHASING

Phase 2 – Minor Street Through and U-turns

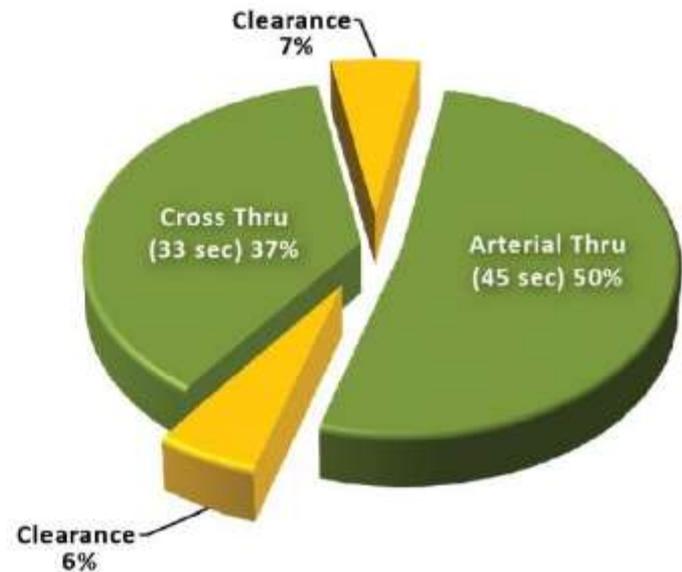


SIGNAL OPERATIONS

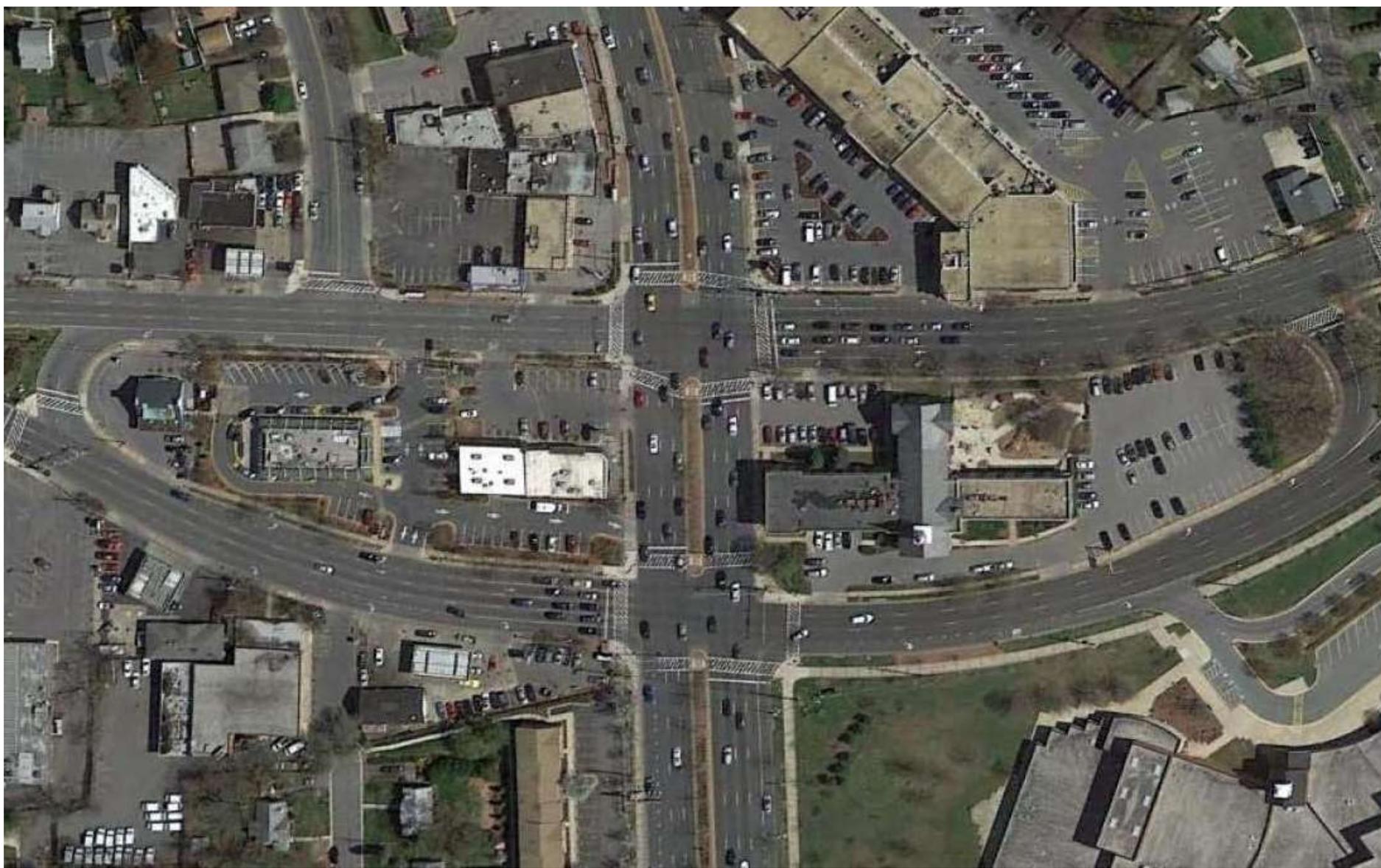
150-Second Multi-Phase Cycle



90-Second Two-Phase Cycle



The MUT removes left-turn phasing, which results in fewer clearance intervals in the intersection cycle and to operate well with a shorter cycle length than a comparable multi-phase cycle



35 minutes hour northeast of Fairfax, ¼ mile north of Exit 30A off Capital Beltway (I-495)

Median U-Turn Intersection

**US 29 and MD 193 (University Blvd)
Four Corners (Silver Spring), MD**

Greenfield Road & 9 Mile Road
Southfield, MI



Median U-Turn Corridors

OK – but ...

What if I'm dealing with an existing arterial that doesn't have a median?



U-TURN INTERSECTIONS: THRU TURN



- Similar to MUT in that direct left-turns are eliminated from main intersection
- Substitutes a paved bump-out or “loon” beyond the outside lane (or coinciding with a sidestreet tee intersection or driveway) for the wide median of a MUT



Draper, UT

Advance Signing at Thru-turn



Tucson, AZ

MULTIMODAL CONSIDERATIONS

SUPERSTREET
AND MEDIAN
U-TURNS

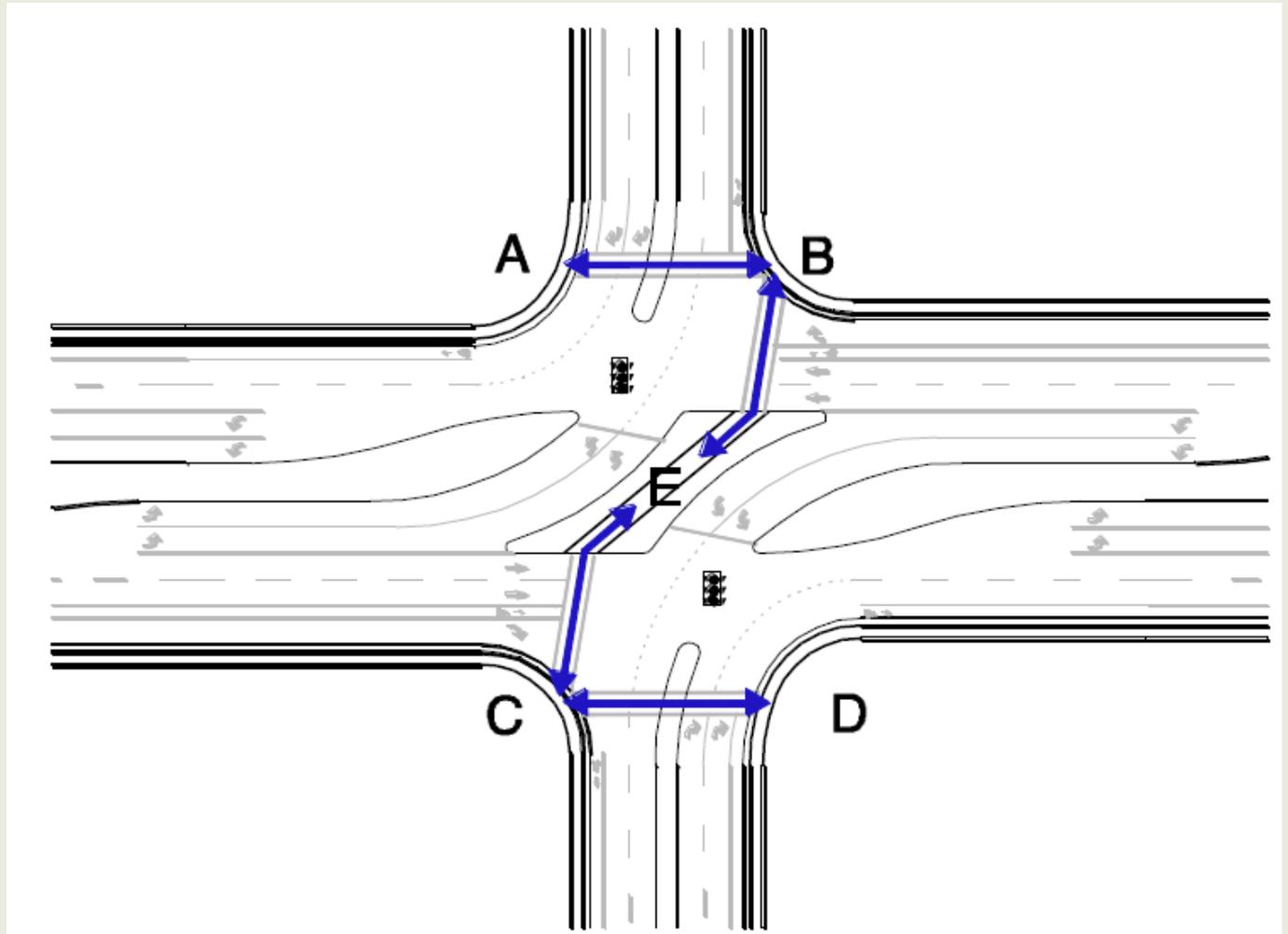
WHY THE BAD REPUTATION FOR PEDESTRIANS AND BICYCLES FOR SUPERSTREETS?

- Initial superstreets installed in locations without pedestrian/bicycle facilities
- Many positive features for pedestrians and cyclists...
 - Safer for all users
 - Less delay for the majority of movements
- ...but the design is not perfect for crossing the major road
 - Multi-stage crossing for some movements
 - Optimal bicycle crossing is being shown to use pedestrian crossing
- Superstreets have not met their full potential yet
 - Use of u-turn locations for crossings
 - More research on pedestrian and bicycle issues
- Superstreet should provide major improvements for pedestrians and bicycles along a corridor like Route 123

PEDESTRIAN CROSSWALKS

Pedestrian crosswalks and pathways in a superstreet

Question: Will pedestrian crossings take longer in a superstreet?



BETTER SIGNAL OPERATIONS FOR PEDESTRIANS TOO?

Superstreet intersection



Average Delay

34 sec (1st stage) |

0 - 75 sec (2nd stage)

4 sec

120 sec



Average Delay

22 sec (1st stage) |

0 - 50 sec (2nd stage)

3 sec

80 sec



Average Delay

23 sec (1st stage) |

0 - 50 sec (2nd stage)

8 sec

120 sec

PEDESTRIAN “Z” CROSSING



**Superstreet in Huntersville, NC
NC 73 @ Holly Point Drive**

PEDESTRIAN “Z” CROSSING



Superstreet intersection in operation near San Antonio, TX

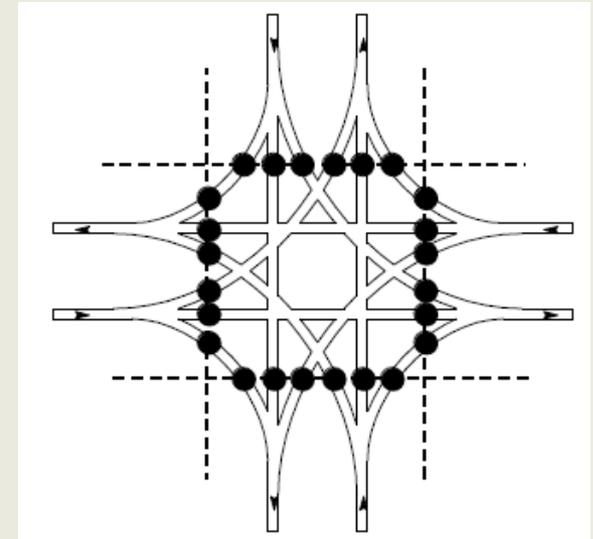
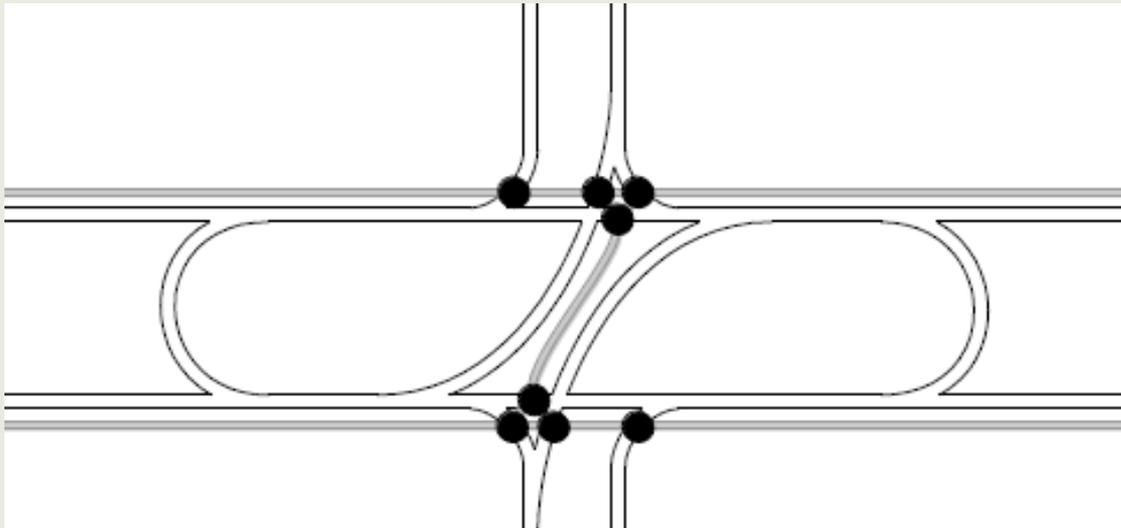
PEDESTRIAN “Z” CROSSING



Superstreet intersection in operation in Crofton, MD

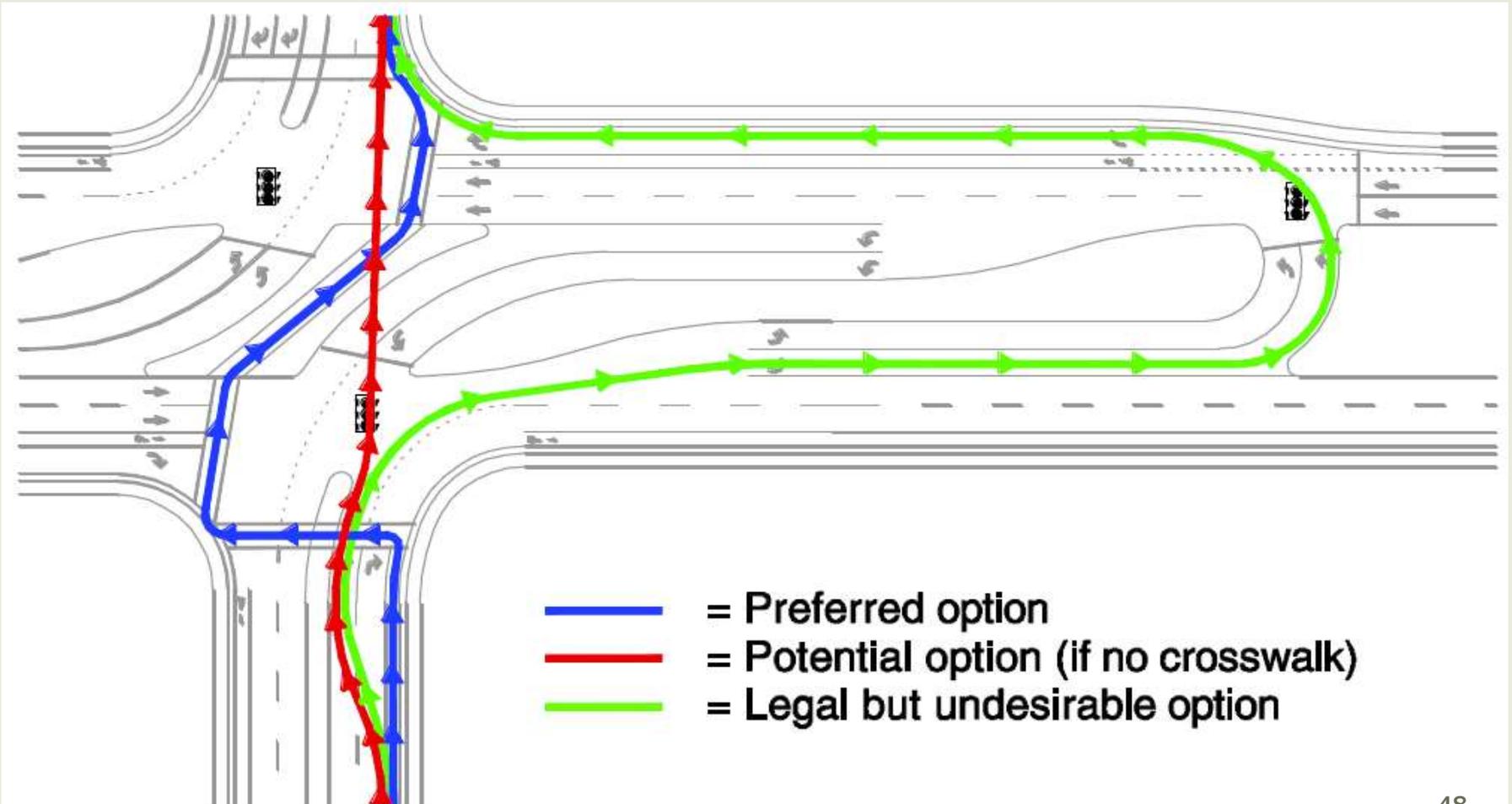
PEDESTRIAN-VEHICLE CONFLICT POINTS

Superstreet Intersection
8 conflict points



Conventional Intersection
24 conflict points

BICYCLE – MINOR STREET THROUGHS

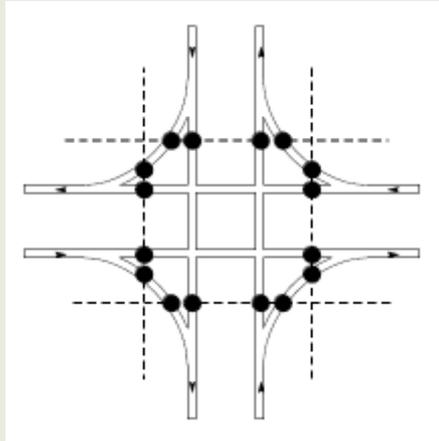


PEDESTRIAN CROSSINGS

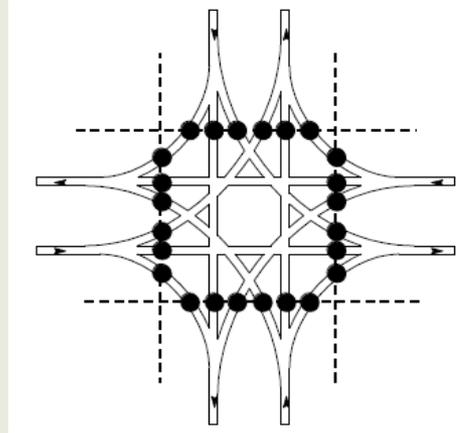
- Major Road Crossing
 - 1 or 2 Stages
 - Median Refuge
- Minor Road Crossing
 - 1 Stage



PEDESTRIAN-VEHICLE CONFLICT POINTS



MUT Intersection
16 conflict points



Conventional Intersection
24 conflict points

At a MUT, the left turns are removed from the main intersection (and shifted to the U-turns located away from the intersection), thus removing pedestrian exposure to left-turning vehicles.

Although the number of pedestrian conflict points at a MUT is reduced, since left-turn demand movements are consolidated into right-turn movements, the total number of vehicles crossing the crosswalk is the same. Consideration of treatments such as a Leading Pedestrian Interval or right turn on red (RTOR) prohibitions may mitigate the conflicts.

PEDESTRIAN WALK PHASES



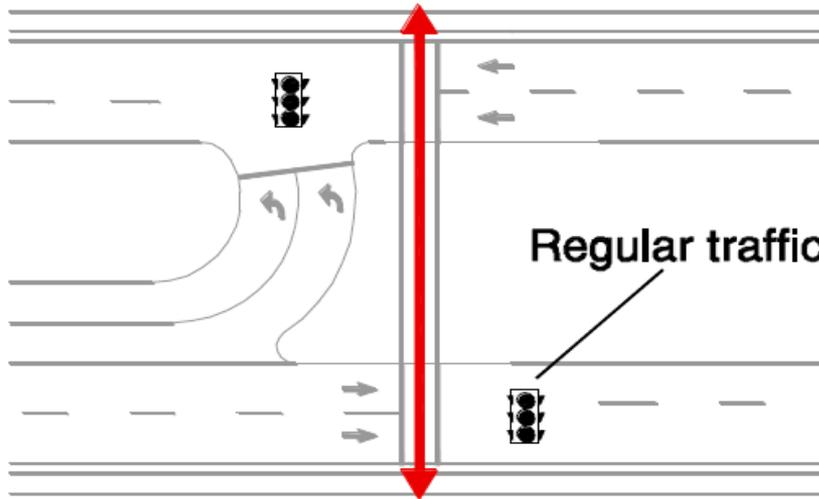
Typical Conventional Intersection Signal Cycle



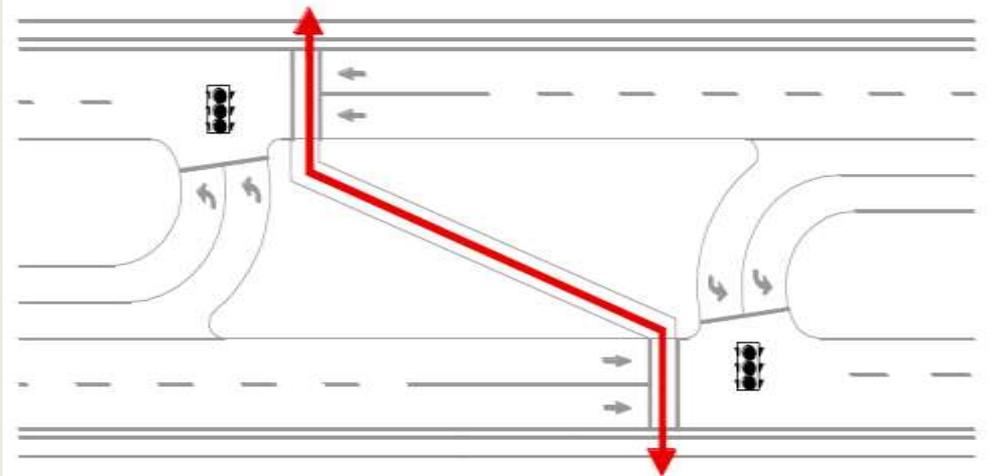
MUT Intersection Signal Cycle

The two-phase signal at a MUT typically allows a shorter signal cycle length compared to a comparable conventional intersection, but with similar green times for pedestrians and vehicles. This benefits pedestrians by creating more pedestrian phases per hour along with less “don’t walk” time between “walk” times (i.e., less wait time between walk signals).

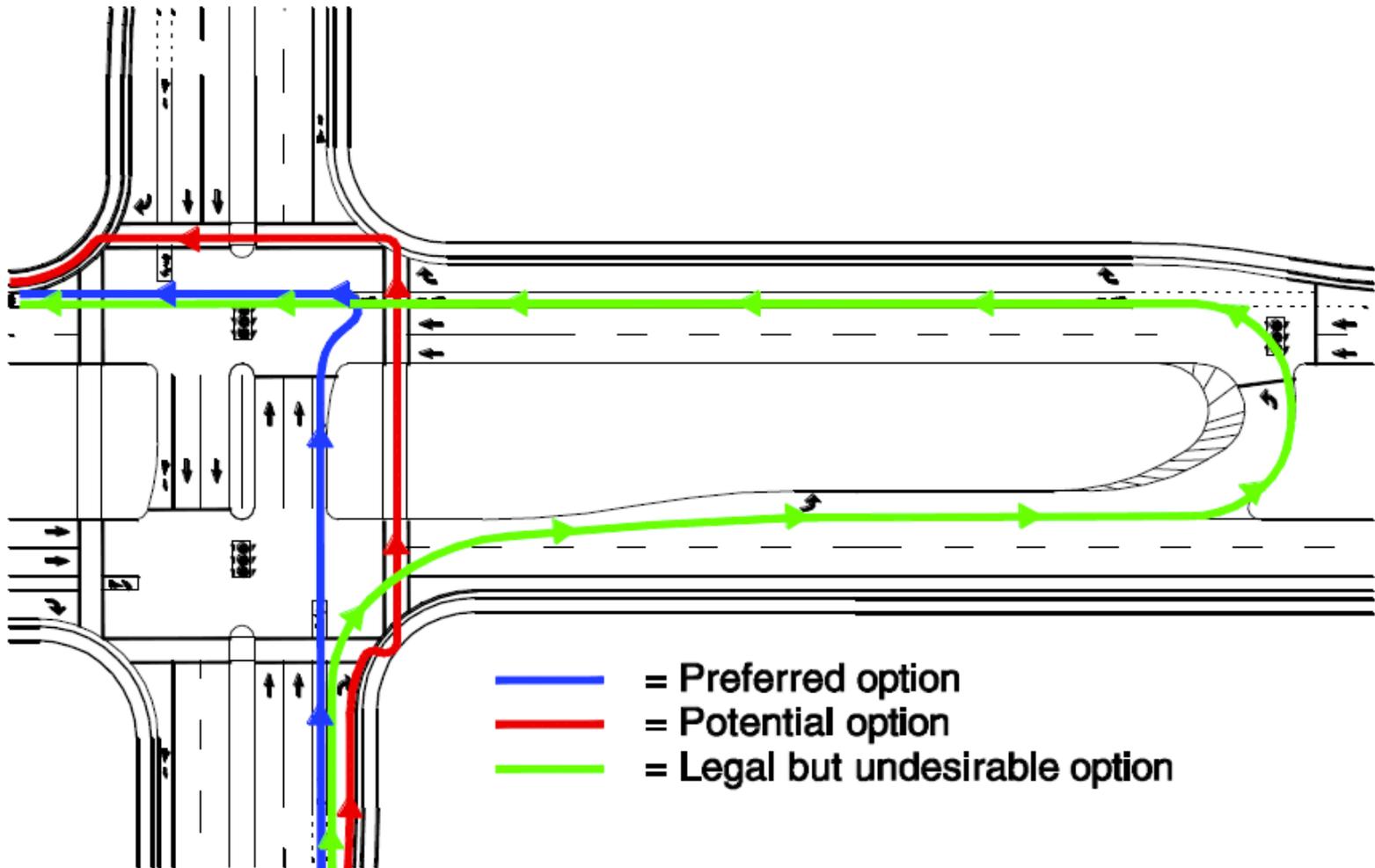
MID-BLOCK PED CROSSING OPTION



Adding pedestrian signal will not interfere with signal progression!!!



BICYCLE – LEFT TURN OPTIONS

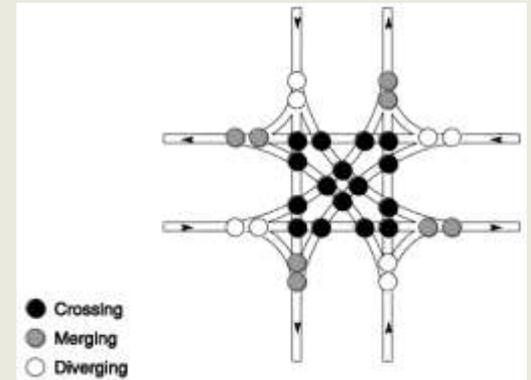


SAFETY BENEFITS

SUPERSTREET
AND MEDIAN
U-TURNS

CONFLICT POINTS

Traditional Intersection:
32 Conflict Points
16 Crossing Conflicts



24 Total Conflict Points

★ 4 Crossing

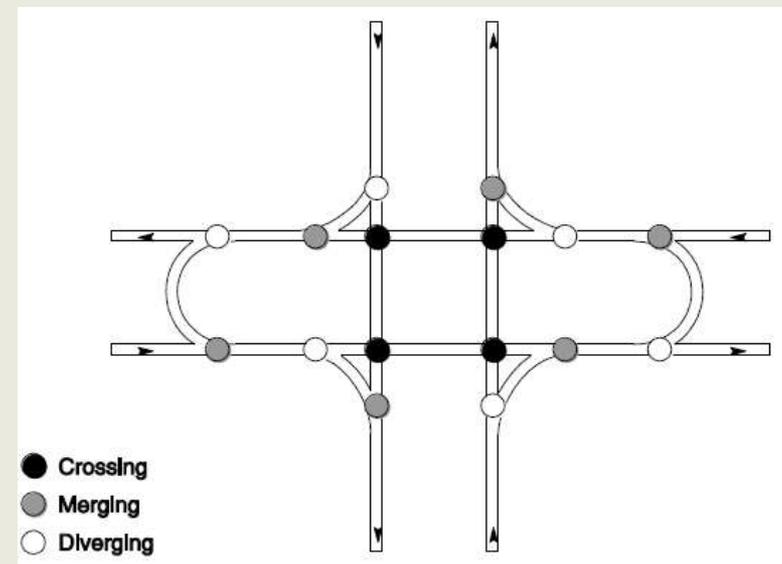
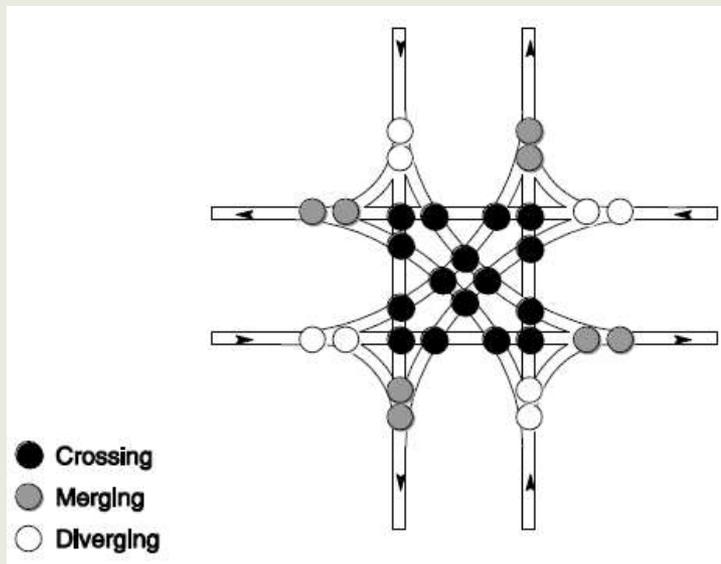
● 20 Merge/Diverge (10 Each)



True apple to apple comparison, superstreets only has 12 conflict points with 2 crossing, all other conflicts are due to multi-lanes

VEHICLE-VEHICLE CONFLICT POINTS

Conventional	MUT
32	16



Crossing conflicts reduced from 16 to 4
Merging and diverging conflicts are each reduced from 8 to 6

SAFETY PERFORMANCE STUDIES

Dataset	Rate Type	Group	Mean Crash Rates (Crashes/MVE)
Corridor	All	MUT (Reduction)	1.554 (14%)
		Conventional	1.806
Intersection Related	All	MUT (Reduction)	1.388 (16%)
		Conventional	1.644
	PDO	MUT (Reduction)	0.982 (9%)
		Conventional	1.077
Injury	MUT (Reduction)	0.407 (30%)	
	Conventional	0.58	

MUT intersections show safety performance improvements compared to conventional intersections for most crash types and injury severities.

Source: FHWA Median U-Turn Informational Guide

CONCLUSIONS

SUPERSTREET
AND MEDIAN
U-TURNS

BENEFITS OF SUPERSTREETS AND MEDIAN U-TURNS

SAFETY

- **Fewer conflict points**
- **Significant Before/After Crash Reductions**

MOBILITY

- **Less delay**
- **Reduced congestion**

VALUE

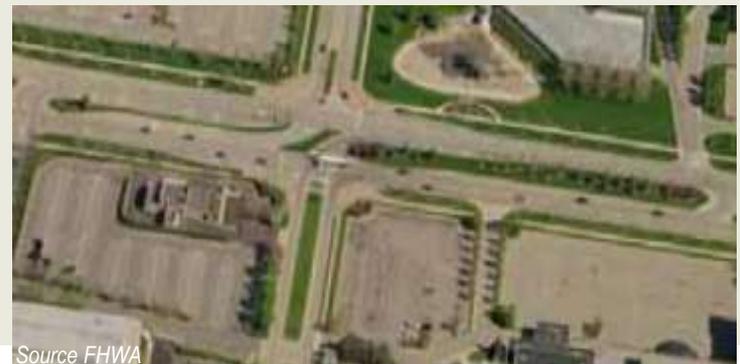
- **Less ROW / construction costs**
- **Implemented quicker**
- **Better access for residents & businesses**

METHODS OF REDUCING CONGESTION

INCREASE SUPPLY – Add more lanes, where possible

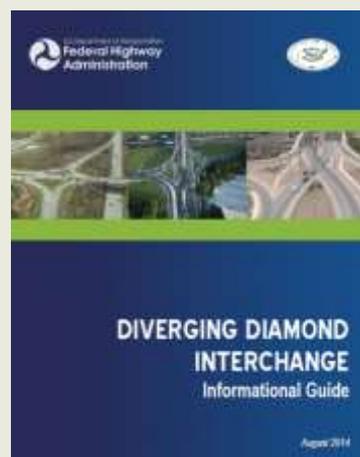
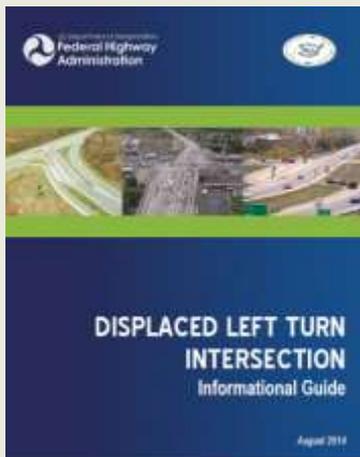
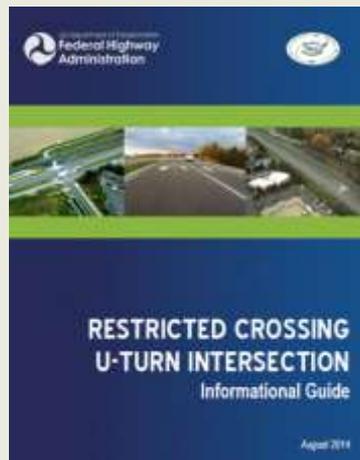
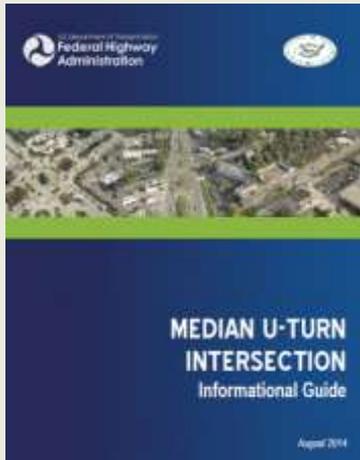
REDUCE DEMAND – Change modes of travel, Improve network, Move traffic to locations that still have capacity.

IMPROVE TRAFFIC FLOW – Better signal timing, Eliminating weaving issues, Reduce signal phasing



Source FHWA

RESOURCES

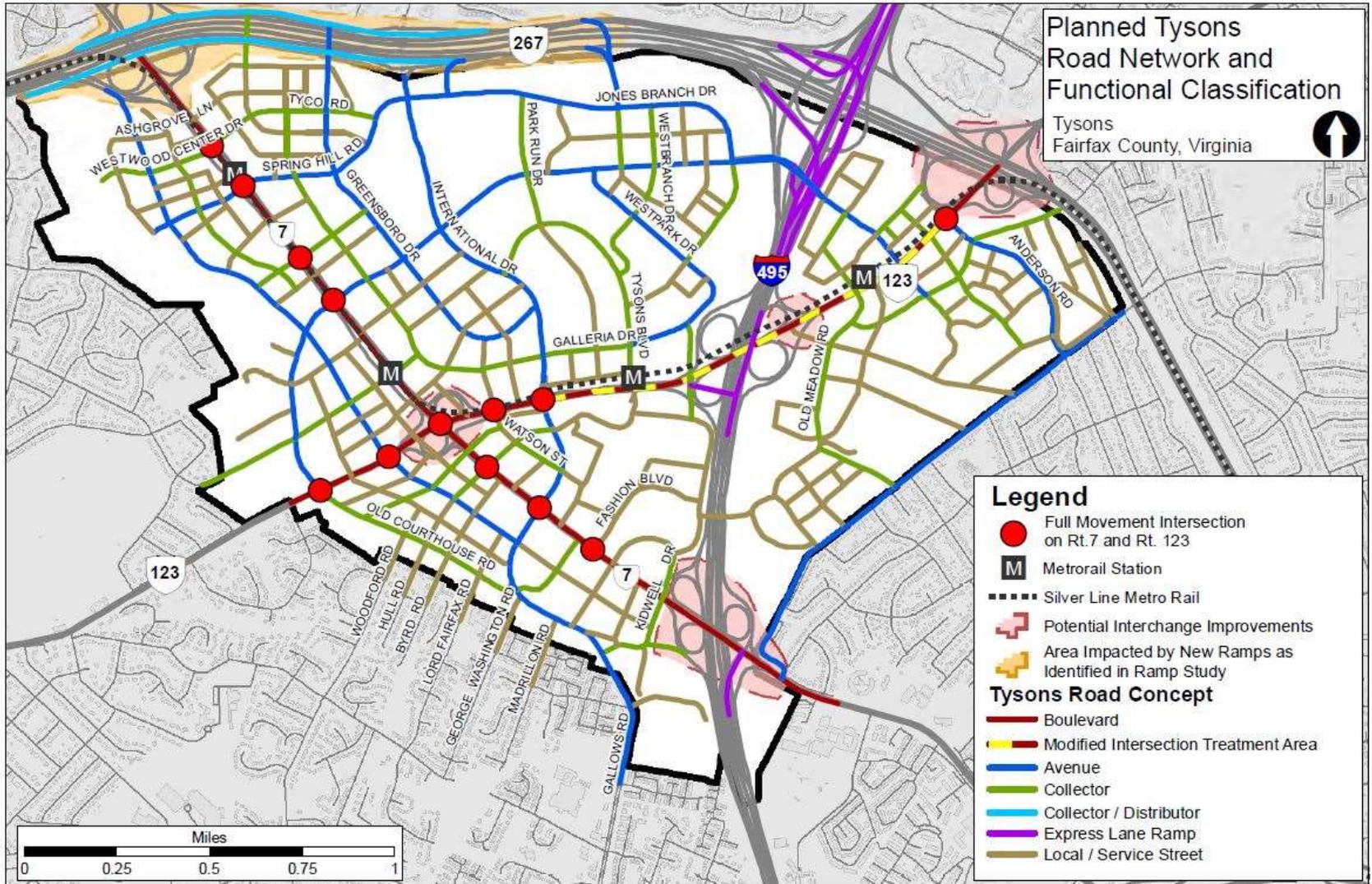


For easy access ...

safety.fhwa.dot.gov/intersection/



TYSONS' SUPERSTREET BOULEVARD



QUESTIONS

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